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(54) **Air-cushion vehicle**

(57) An air-cushion vehicle having a fan unit (16) for propelling air rearwardly of the vehicle to move the vehicle, a duct (22) being located on the rearward side of the fan unit (16) for receiving some of the airflow from the fan unit (16) and for conveying the air to the plenum chamber (13) formed on the underside of the vehicle to provide the air-cushion, the duct (22) being provided with a pivotable flap member (29) movable between a position in which all the air flowing through the duct is conveyed to the plenum chamber (13) and a position in which all the air flowing through the duct is discharged rearwardly to assist in propelling the vehicle. The flap (29) may be selectively adjusted to any intermediate position. A spider (29g) prevents Coanda effect of air above the flap (29) following the surface curvature of the flap. The vehicle may be operated as an air propelled boat, with skirt (12) removed.

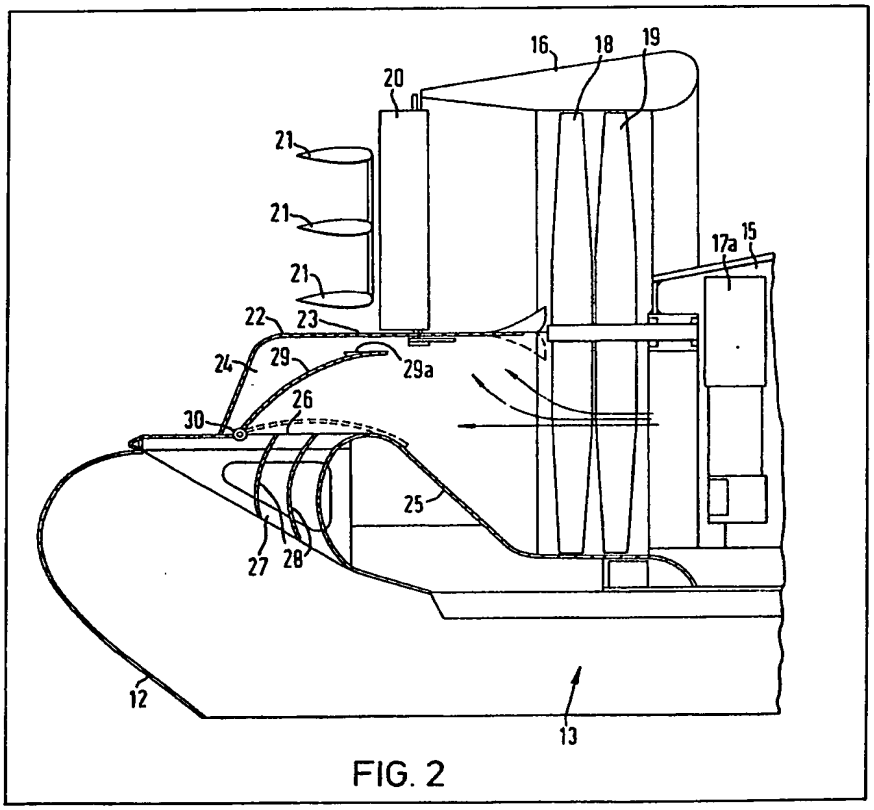


FIG. 2

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

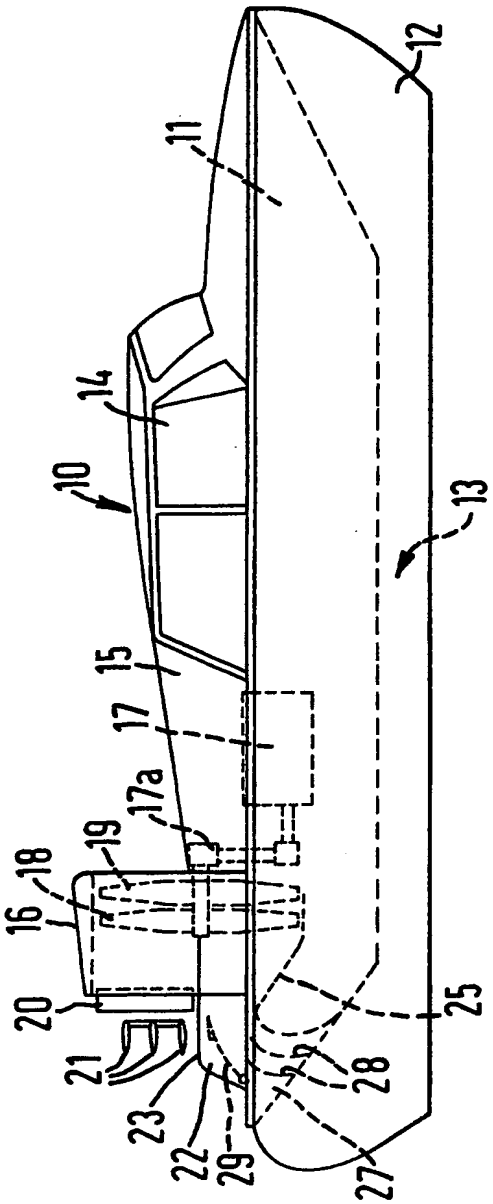


FIG. 1

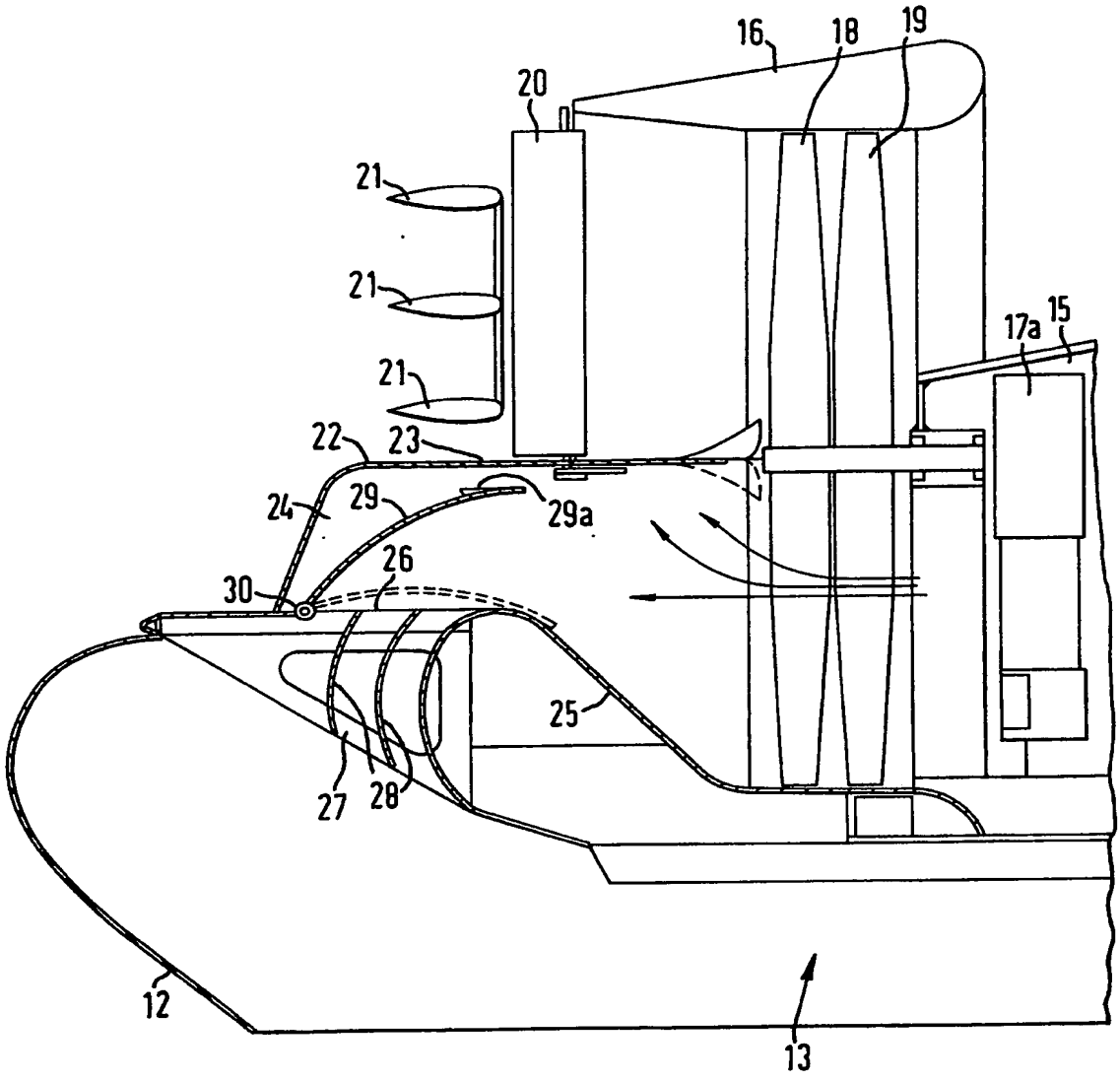


FIG. 2

SPECIFICATION
**Air-cushion vehicle**

This invention relates to an air-cushion vehicle of the type in which air from a fan unit is used for propelling the vehicle and for forming the air cushion on which the vehicle is normally propelled.

According to the present invention there is provided an air-cushion vehicle having a fan unit for propelling air rearwardly of the vehicle, a duct located on the rearward side of the fan for conveying part of the airflow from the fan to a plenum chamber formed on the underside of the vehicle, and a flap member located in said duct and pivotable between a position in which all the air flowing through said duct is conveyed to said plenum chamber and a position in which all of the air flowing through said duct is discharged rearwardly of the duct to assist in propelling the vehicle.

Preferably the upper wall of the duct is located in a horizontal plane containing the axis of the fan.

When the flap member is in the position in which all of the air flowing through the duct is discharged rearwardly maximum propelling thrust is achieved and the hull of the vehicle then contacts the surface over which the vehicle is to be propelled, such as water, enabling a greater payload to be carried.

An embodiment of the invention will now be described, by way of an example, with reference tc the accompanying drawings, in which:—

Figure 1 is a diagrammatic side elevation of an air-cushion vehicle according to the present invention, and

Figure 2 is a longitudinal section view of the rear end of the air-cushion vehicle on a larger scale.

The air-cushion vehicle 10 has a hull 11 provided with a downwardly extending flexible peripheral skirt 12 forming a plenum chamber 13 on the underside of the vehicle. The hull 11 is provided with a cabin 14, an engine compartment 15 and a fan unit 16 which is driven by an engine 17 through a suitable transmission 17a. The fan unit 16 is provided with two bladed fan rotors 18 and 19 and at the downstream end of the fan unit 16 are provided a plurality of vertical rudders 20 which are pivotable about their leading edge region so as to direct the air-flow from the fan unit 16 to one side of the other of the axial direction in order to provide directional control of the vehicle 10. Downstream of the rudders 20 are a plurality of horizontal flaps 21 which are normally in the horizontal position as shown but which can be pivoted to a vertical position in which they prevent rearward flow of air from the fan 16 and thus reduce forward propelling thrust of the fan air to zero.

Located rearwardly of the fan unit 16 is a duct 22 formed by a horizontal upper wall 23, side walls 24 and a lower wall 25. The cross-section of the duct 22 is a semi-circular segment at its forward end and rectangular at its rearward end.

The lower wall 25 is provided with an opening 26 communicating with a passage 27 leading into the plenum chamber 13, said passage 27 being provided with curved vanes 28.

The horizontal upper wall 23 is located in a horizontal plane containing the rotational axis of the fan rotors 18 and 19. The leading edge of the upper wall 23 is curved upwardly on one side of the fan axis and curved downwardly on the other side of the fan axis so as to intercept the rotating airflow downstream of the fan rotors 18, 19 with zero or negligible angle of attack. With this particular arrangement 50% of the air-flow from the fan enters the duct 22. It will be appreciated that the upper wall 23 may be positioned above or below the horizontal plane containing the rotational axis of the fan rotors 18, 19 so that more than 50% or less than 50% of the airlfow enters the duct 22.

Located at the downstream end of the duct 22 is a curved flap member 29 pivoted at 30. The flap member 29 is movable about the pivot 30 between a position in which it contacts the upper wall 23 and directs all of the air flowing through the duct 22 into the opening 26 and thus into the plenum chamber 13 via the passage 27, and a position in which it contacts the lower wall 25 and closes the opening 26 so that all of the air flowing through the duct 22 is discharged rearwardly from the duct 22 to increase the propelling thrust on the vehicle 10. The position of the flap member 29 can be varied between each of its extreme positions so that the percentage of air from the fan 16 fed to the plenum chamber 13 can be varied from zero to 50% of the total fan airflow. A greater percentage can be taken if the upper wall 23 is located above the horizontal plane containing the axis of the fan rotors 18, 19.

To avoid the possible Coanda effect of the air flowing over the top of the flap member 29 a flow separating device, 29*a*. is positioned on the top surface of flap member 29. This device is so designed as to permit the highest thrust to be obtained at any setting of flap member 29.

When all the fan air is excluded from the plenum chamber 13 the hull 11 of the vehicle 10 contacts the surface over which the vehicle is to be propelled but maximum propelling thrust is achieved. When travelling over water the vehicle 10 can then be operated as an air propelled boat, with the skirt 12 removed, enabling it to carry a greater payload. The vehicle 10 may be operated as a sea rescue vehicle, in which case it will travel at fast speed on its air cushion to the scene of rescue and return as an air propelled boat when heavily laden with rescued persons.

The ability to vary the percentage of air used for propelling thrust and air supplied to the plenum chamber 13 also enables the vehicle 10 to be propelled over a variety of surfaces e.g. water, mud, shingle, grass etc., with the optimum thrust/lift airflow combination, shingle surfaces and grass, for example, requiring greater lift airflow to the plenum chamber 13 than a hard smooth surface such as concrete.

When very steep gradients are encountered by the vehicle 10 there may be situations where a larger percentage of air from thrust will enable the vehicle to climb the gradient at steady speed, thus avoiding the necessity for a high speed approach to the gradient. In this situation the plenum chamber 13 is still under pressure but skirt surface contact is increased, though not enough to offset the thrust gain.

The use of tandem fan rotors 18, 19 has the advantage of low tip speed and the power is absorbed in two stages. For a given diameter and tip speed the cushion pressure for lift-off can be obtained at a relatively low r.p.m., the fan pressure generated approaching the sum of the individual pressures generated by each fan rotor. By positioning the blades of the rear fan in close proximity to the blades on the front fan it is possible to obtain a "slotted flap effect", thereby enhancing the performance compared with fans operating in tandem, but at a wide apart spacing. The slotted flap effect can result in a reduction in noise level.

CLAIMS

1. An air-cushion vehicle having a fan unit for propelling air rearwardly of the vehicle, a duct located on the rearward side of the fan for receiving and conveying part of the airflow from the fan to a plenum chamber formed on the underside of the vehicle, and a flap member located in said duct and pivotable between a position in which all of the air flowing through said duct is conveyed to said plenum chamber and a position in which all of the air flowing through said duct is discharged rearwardly of the duct to assist in propelling the vehicle.

2. An air-cushion vehicle as claimed in claim 1, in which the upper wall of the duct is located in a horizontal plane containing the axis of the fan.

3. An air-cushion vehicle as claimed in claim 1, in which the upper wall of the duct is located in a horizontal plane disposed above a horizontal plane containing the axis of the fan.

4. An air-cushion vehicle as claimed in any preceding claim, in which said flap member is curved in longitudinal section and pivoted to the lower wall of said duct.

5. An air-cushion vehicle as claimed in any preceding claim, in which the duct at its forward end is semi-circular and at its rearward end is rectangular.

6. An air-cushion vehicle as claimed in any preceding claim, in which the lower wall of the duct is provided with an opening which communicates with a passage leading to the plenum chamber.

7. An air-cushion vehicle as claimed in claim 6, in which the passage is provided with curved vanes.

8. An air-cushion vehicle as claimed in any preceding claim, in which the leading edge of the upper wall of the duct is curved upwardly on one side of the fan axis and curved downwardly on the other side of the fan axis so as to intercept the rotating airflow of the fan rotor with zero or negligible angle of attack.

9. An air-cushion vehicle as claimed in any preceding claim, in which the upper surface of the flap member is provided at its forward end with a flow separator.

10. An air-cushion vehicle as claimed in any preceding claim, in which the fans has two bladed rotors.

11. An air-cushion vehicle as claimed in any preceding claim, in which downstream of the fan and above the duct are vertical rudders which are pivotable to provide directional control of the vehicle, and horizontal pivotable flaps for controlling the thrust of the airflow from the fan.

12. An air-cushion vehicle substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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